

Discussions on aerosol water and the hygroscopicity experiment

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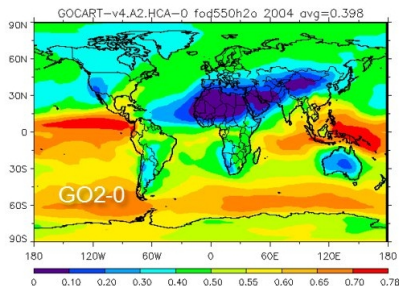
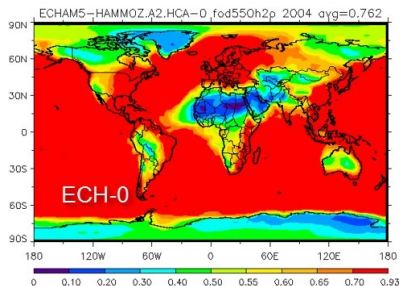
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October 10th, 2017



Stockholm
University

Diversity among AeroCom models



Fraction of AOD due to water (left: ECHAM5 with global annual average of 76%; right: GOCART with 40%)

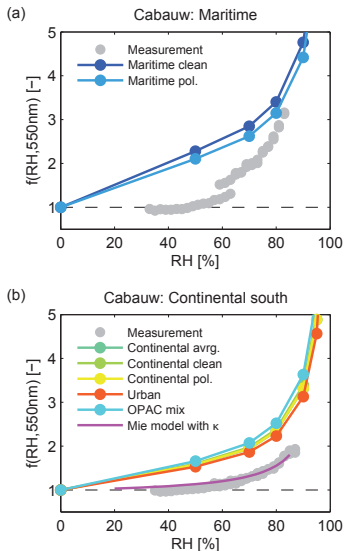
Source: Mian Chin (NASA Goddard)

- ▶ AeroCom questionnaire from 2011: 14 models use 10 different hygroscopicity parametrizations (e.g. 2 use OPAC/GADS, 2 use κ -Köhler-approximation)

Importance of ground-based in-situ measurements for model improvement

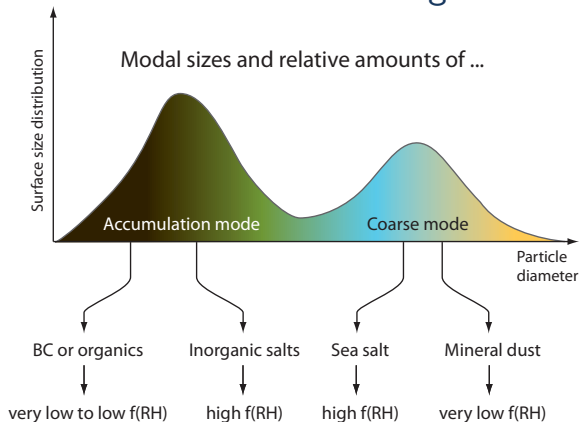
OPAC: Optical Properties of Aerosol and Clouds (Hess et al., 1998)

- ▶ OPAC generally higher than measurements especially for low-medium RH
- ▶ Reason: Too high growth factors for sea salt and sulfate components

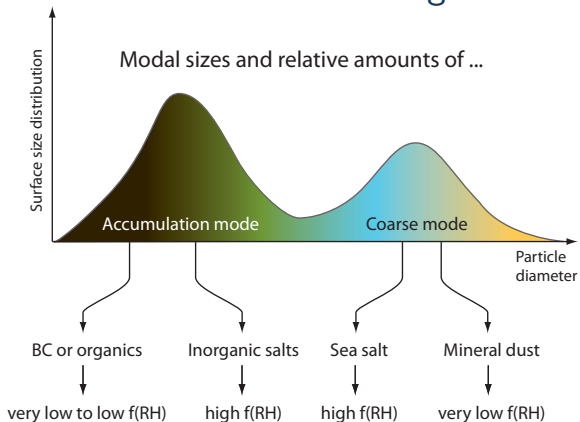


Source: Zieger et al. (2013)

What determines the scattering enhancement?

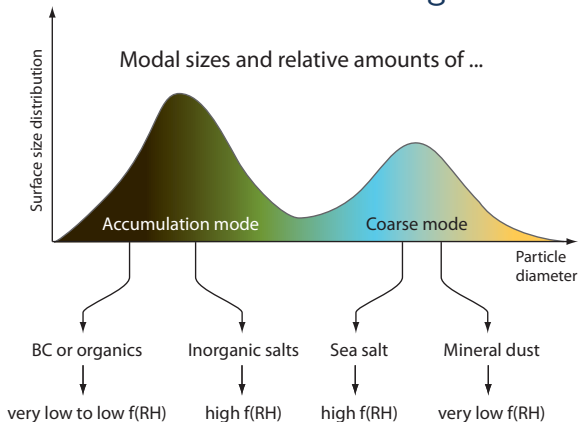


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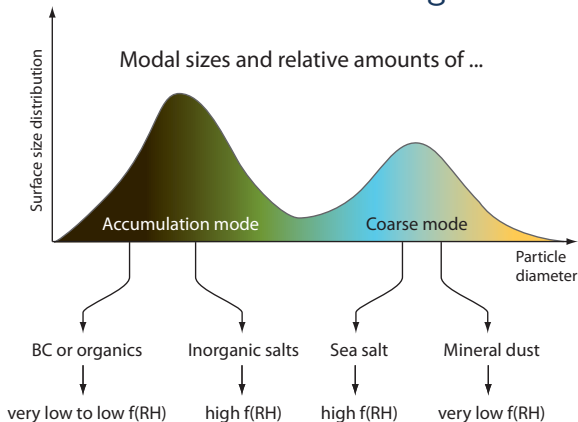
- Size and chemical composition matter

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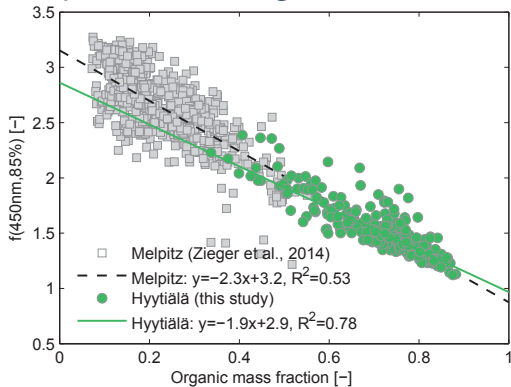
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- ▶ Importance of larger particles (coarse mode) and hysteresis behavior (RH history)

What determines the scattering enhancement?



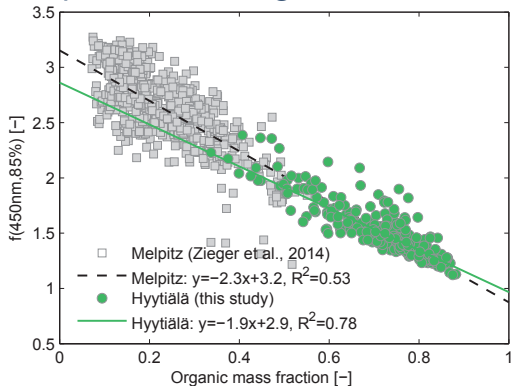
- ▶ Size and chemical composition matter
- ▶ Importance of larger particles (coarse mode) and hysteresis behavior (RH history)
- ▶ Site or aerosol type dependent

Example: Scattering enhancement vs. organic mass fraction



- Organics $\uparrow \rightarrow f(\text{RH}) \downarrow$
- Inorganics $\uparrow \rightarrow f(\text{RH}) \uparrow$

Example: Scattering enhancement vs. organic mass fraction



- ▶ Organics $\uparrow \rightarrow f(\text{RH}) \downarrow$
Inorganics $\uparrow \rightarrow f(\text{RH}) \uparrow$
- ▶ Relationship will not hold for other aerosol types (e.g. coarse mode dominated)

Planned AeroCom experiment

Can we give any recommendations to modelers?

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Not yet.

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Main things that influence the ambient optical properties of aerosols:

- ▶ Aerosol size distribution
- ▶ Chemical composition
- ▶ Ambient RH
- ▶ Absorption coefficient
- ▶ Further assumptions (e.g. mixing state)

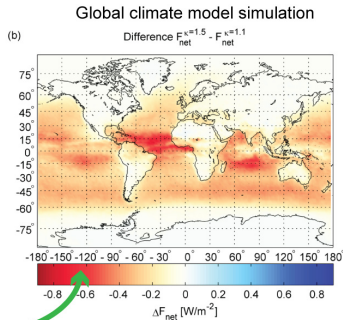
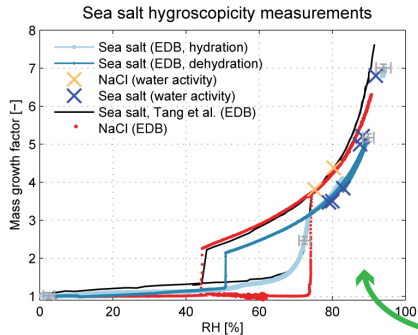
Hess M., Koepke P., and Schult I., Optical properties of aerosols and clouds: The software package OPAC, *Bull. Amer. Meteor. Soc.*, 79(5), 831–844, 1998.

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Zieger P., Väisänen O., Corbin J., Partridge D.G., Bastelberger S., Mousavi-Fard M., Rosati B., Gysel M., Krieger U., Leck C., Nenes A., Riipinen I., Virtanen A., and Salter M., Revising the hygroscopicity of inorganic sea salt particles, *Nature Communications*, 8(15883), doi:10.1038/ncomms15883, 2017.

Hygroscopicity of sea spray aerosol



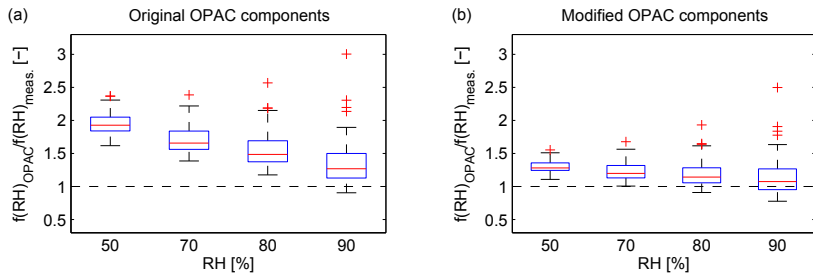
Source: Zieger et al. (2017)

Importance of ground-based in-situ measurements for model improvement

Better agreement can be achieved if hygroscopic growth of water-soluble and sea salt components is modified:

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